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ORIGINAL ARTICLE

A micro-level analysis of the intensity of agricultural finance supply in Nigeria: empirical evidence

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Abstract
Agricultural credit provides access to all other resources, which may lead to remarkable improvement in agricultural productivity. This study aims to model the determinants of credit supplied to farmers by microfinance banks. A total of 835 households and 45 microfinance banks were utilized as the samples of the study. The result of the Tobit model shows that the entrepreneurial ability of the farmers, having an account with the bank, profits from loan and the number of marketing staff of the banks have positive impacts on loan supply. Contrarily, the higher the distance of customers from the banks, the lower the intensity of loan supply. The study recommends that pro-poor credit policies are required for the establishment of new agencies and financial institutions devoted to agricultural sector. Such financial agencies should be established closer to farmers especially those in remote areas. Moreover, policies should focus on rural development through the activities that could generate off-seasonal employment.

Keywords Agricultural · Finance supply · Determinants · Tobit

JEL Classification Q130 · Q140

Introduction

It is generally agreed that farm credit enhances farm performance and productivity, thereby ensuring a significant improvement in rural welfare and farmers' income (Danlami et al. 2019a; Nwaru 2011). Farm credit is one of the crucial inputs considered fundamental in agricultural production. It is a way of enhancing the capital use in agricultural production by rural farmers. Perhaps, to improve farming production

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and increase the welfare of rural dwellers, farmers have to use improved techniques of production (Danlami 2014a, b; Kofarmata and Danlami 2019; Nuryartono et al. 2005). However, the adoption of these modern agricultural inputs and machineries are somehow expensive and most farmers cannot afford to self-finance. That is why, the adoptions of modern agricultural inputs and new machineries are very rare in Nigeria. Therefore, the desire for the peasants to switch from subsistence to mixed or commercial farming is hampered by the inability to obtain credit, imperfect market, low productivity, low income and investment.

In response to these issues, Nigerian government for over 40 years has been establishing a lot of programs and policies aimed at increasing production and access to credit. Some of these programs and policies include; the establishment of Agricultural Credit Guarantee Scheme Fund (ACGSF) in 1977 and Nigerian Agricultural Cooperative and Rural Development Bank (NACRDB) in 2000 and later Bank of Agriculture (BOA) in 2010 (Odi 2013; Odi et al. 2013; Okpara 2010; Tsauni and Danlami 2016). But in spite of these efforts and measures, the supply of credit to agricultural sector is still insufficient, and majority of rural farmers have very limited access to agricultural finance in Nigeria.

Moreover, the conditions were not only aggravated and limited to commercial banks' lending, but also, statistical evidence from CBN (2015) showed that even the well-established government financed programs (such as ACGSF), agricultural loans are no longer available for most of the farmers. For instance, in year 2014, only 69,062 individuals, 1,275 informal groups, 1,912 cooperatives and 73 companies had access to government-financed credit in the African largest country (Nigeria) under ACGSF (CBN 2005).

Such inadequate agricultural credit in the country has adverse consequences on savings, investment and rural welfare. It increases the level of farmers' poverty, deteriorates farm performance, and further worsens the welfare condition of rural farmers. Also, such poor access to credit and non-availability of lending agencies remain the key drawbacks to the growth of agricultural sector in Nigeria. Additionally, Inyang (2013) explained that lack of access to credit is among the significant obstacles confronting farmers across Nigeria, which deteriorate the modernization and expansion of many farms. This problem reduces the value of agricultural contribution to GDP, lowers cereal productivity, and skyrockets the food import bills of Nigeria. In addition, the fact that formal financial sector provides services to only 44 percent of nearly 200 million Nigerians; and formal loan covers only 5% of the population highlight the problems in the sector. Due to the issues highlighted above, this study raises some questions as; what are the determinants of the amount of credit supplied to farmers by microfinance banks? How can these factors be influenced to increase the intensity of agricultural loan supply by microfinance banks in the study area? The issues highlighted and the above questions raised justified the need for empirical investigation of the determinants of intensity of credit supply to farmers by microfinance banks in Kano State, Nigeria.

This study is important because the findings of this research can serve as a source of information to interest groups and governments at various levels involved in channelling credit to farmers. This information is vital for the development of agriculture

in modifying the lending procedures and awareness to farm credit. More importantly, on its contribution on how to alleviate poverty by breaking the vicious circle of poverty in the farming communities. Similarly, this study has compiled a new micro-level dataset in the study area, which could also supplement micro-level data for other areas that could be used as a source of knowledge and comparison. Moreover, one of the most important contributions of this study to literature in general is the ability for the research to include a number of potential determinants of agricultural credit supply that have not been tested before within the Nigerian context. The remaining part of the paper is explained as follows. The next section consists of theoretical framework and empirical literature review followed by which the entire methodology of the research is discussed. The subsequent section presents the result of the estimated model and discussion. The penultimate section is the conclusion of the study. The policy recommendations based on findings are given before the final section. The last section consists of the suggestions for future researches.

Theoretical framework and review of empirical studies

A theoretical framework for credit supply and access is developed in this section. The provision of the credit supply is subject to lender's decisions which in turn is determined by the marginal cost and revenue of the credit contract. This decision-making process can be analysed "The decision of the lenders".

The decision of the lenders

Usually, lenders decide to grant a loan to a farmer if the marginal revenue of the credit is higher than the marginal cost ($MR^F > MC^F$). For simplicity, the theoretical model assumes that a loan applicant either receives his requested amount or totally rationed from participation in the credit market. A dummy variable, S defined as: $S_i = \{1$, if lender i grant loan to the borrower j; and 0, otherwise$\}$. In this case, the framework of marginal revenue and cost that applies in this analysis is grounded from the work of Kochar (1997), and also formalised following Greene (1977):

$$S_i = f\{\mathrm{MR}, \mathrm{MC}(L, W, C, P, X)\}, \tag{1}$$

$$S_i = 1, \text{if MR} > \mathrm{MC}(L, W, C, P, X), \tag{2}$$

$$S_i = 0, \text{if MR} < \mathrm{MC}(L, W, C, P, X), \tag{3}$$

where MR is equal to marginal revenue of the lender, $\mathrm{MC}(L, W, C, P, X)$ is the marginal cost of offering credit, L is a set of variables representing credit terms, W is a set of wealth-related variables, C is a set of variables related to the history of the farmer, P is a set of variables connected to the productivity and X is a set of

demographic variables. For the formal lender, the marginal revenue of the credit is the exogenously fixed interest rate and other cost associated with contract. Though this interest rate which is the price for a loan is set by the monetary authority and is not allowed to differ with the size of a credit (Kochar 1997).

Numerous types of costs are involved in transaction which includes administrative costs (screening and monitoring cost of loan applicants, processing costs, delivering and administering loans) and risk of default (Atieno 2001). Bigger loans and long amortizations usually decrease administrative costs because of economies of scale. Thus, the terms of the contract (L) will affect the marginal cost of credit. Defaulting risk is dependent on the farmer's credit history (C) and solvency which is influenced indirectly by borrower's wealth (W) and the project for which the purpose of the loan is requested (Briggeman et al. 2009; Omonona et al. 2008). Duy et al. (2012) found that formal lenders grant a higher proportion of credit to richer individuals than poorer ones. This indicates a wealth bias in the literature of credit rationing by formal lenders. With regard to production loans, productivity of agriculture (P) will play a significant role in determining the level of loan return, and consequently, the repayment capacity of a farmer. In summary, the marginal cost of credit is affected by administrative costs and the default risk, such that lenders may choose to offer loan to borrowers if the benefit of lending is higher than the marginal cost of the credit contract. On the other hand, for the government and interest groups, lending is possible if the benefit outweighs the cost.

Review of empirical literature

At the level of households, credit supply is determined by factors such as business enterprises, residential location, accumulated wealth and the total household income (Barham et al. 1996; Foltz 2004; Nuryartono et al. 2005). The empirical surveys of China and Nigeria, by Yu (2009) and Oyedele et al. (2009) found that older farmers are less likely to be supplied with loans than the younger farmers because the later have higher probability of repaying back than the older farmers. This conforms with the intuitions of Omonona et al. (2010) that older farmers are less aggressive to income generating activities and less amenable to new technologies, and therefore, less likely to save and invest compared to younger farmers. Hence, the younger farmers have more chances of being supplied with credit. However, this is not in line with the findings of Okurut et al. (2005) and Teppa et al. (2013).

Moreover, years of farming business experience was found to have a negative relationship with credit constraint (Omonona et al. 2008). Contrarily, households with main business in non-farming activities have higher probability of experiencing credit constraints in china (Tang et al. 2010). This is in line with the conclusion of Papias and Ganesan (2010) in rural Rwanda, Diagne and Zeller (2001) in Malawi and with those of Zeller (1994) in Madagascar, but dis agreed with the findings of Omonona et al. (2008) in Nigeria and Kochar (1997) in India.

Furthermore, some studies revealed that wealthier farmers are less likely to be credit constraints (Kuri and Laha 2011; Pederson et al. 2012; Shoji et al. 2012; Teppa

et al. 2013; Oyedele et al. 2009). Poor farmers have higher probability of being credit rationed. This is due to the lenders' perception and belief that the probability of loan repayment by poor households is very low. Additionally, studies by Nguyen and Luu (2013) and Li et al. (2013) in China indicated that social capital has a significant impact on the activities in the credit market. In the same vein, studies found that the higher the distance from the lending agencies the lesser the amount of credit supply (Akudugu 2013; Godquin and Sharma 2005; Papias and Ganesan 2010). This is because, the further away from the lending agencies, the higher the costs of transaction (Akpan et al. 2013; Ejaz and Khan 2011; Shoji et al. 2012). Given this situation, households tend to have little access to farm credit. This is due to the fact that increase in the distance between lenders and borrowers, increases the cost of transaction making lending to become unviable in the sight of the lenders.

In addition, number of marketing staff was found to have a significant influence on the quantity of loanable funds supply. In line with the assertion that inadequate number of bank branches available in the rural areas increases transaction cost, thereby discouraging individuals from credit participation (Bakhshoodeh and Karami 2008). Therefore, availability of banks proxied by number of marketing staff decreases the cost of borrowing consequently, leading to increase in credit supply (Kuri and Laha 2011). Likewise, some previous studies established that the wealth of the borrowers has a negative relationship with credit constraints. An increase in the liquidity ratio in the hand of lenders increases the supply of more loanable funds (Dohcheva 2009; Foltz 2004; Ibrahim and Bauer 2013). This is in line with the findings of Nwaru (2011) that the supply of credit is likely to increase as a result of increase in liquidity possession of the lenders. This also conforms to the finding of Pham and Lensink (2008) in Vietnam that there is a positive relationship between credit disbursement and liquidity ratio.

Moreover, some studies established that membership in a farming group minimises the status of credit constraints for many farmers that faced credit restrictions before in China, Tanzania and Malawi (Diagne and Zeller 2001; Yu 2009). Finally, collateral possession was found to have a significant impact on credit rationing (Fhima and Bouabidi 2011). The chance of being constrained from credit decreases with possession of collateral by farmers (Godquin and Sharma 2005; Hartarska 2012; Lawal et al. 2009).

Therefore, based on the literature reviewed, it is realized that there exist inconsistencies as per the findings of the previous studies on the determinants of agricultural loan supply in different areas of studies due to the fact that the factors that influence agricultural credit supply are not equally important in different areas because of socio-economic and cultural differences, differences in geographical and institutional settings as well as the nature of farming. Hence, taking a new environment of study on agricultural credit supply is a knowledge addition to the existing literature.

Methodology

This section contains information on the, sampling process, data collection procedure, type and sources of data.

Sampling technique and sample size

Probability sampling technique was used in this study. Initially, in addition to microfinance banks, the targeted respondents were divided into two categories, namely participants in credit market and non-participants. In the second stage, the respondents were further stratified on the basis of the various agricultural zones. Based on this, the selection of respondents was made from the selected six local government areas: Kura, Wudil, Gezawa, Dambatta, Ungoggo and Minjibir. These local government areas were chosen from three different agricultural zones. This selection was justified by the target of the research to incorporate different zones in the analysis. This is also amplified by the wish of the study to have diverse responses from rural, semi-urban and urban inhabitants.

Additionally, these steps adopted give an opportunity for the study to control and capture the impact of regional differences and opportunities associated with each zone. For instance, Gaya region is stratified as rural area, farmers in this region are anticipated to gain from the existence of BOA in their locality. On the other hand, Rano region is stratified in the semi-urban area; it has the biggest land area coverage for irrigation farming in the country, which provides the chance for farming all over the season. Lastly, Dambatta region is stratified as an urban area, due to the large concentration of banks within the region and it is also a strategic area of being part of the metropolis. In addition to the aforementioned, the biggest agricultural market in the continent of Africa is located in the area under Dawakin Tofa Local Government.

However, as for the sample size determination, based on the Dillman (2000), a population of 271,233 demand a sample size of 384 using the formula:

$$n = \frac{(N)(P)(1-P)}{(B/C)^2(N-1)+P(1-P)}, \tag{4}$$

where n is the targeted sample size of the study to be computed, N is the population size, B is tolerable sampling precision or error, P is the proportion of population likely to choose, C is the Z statistic with the confidence level of 1.96, tallies to the 95% level. Therefore, $C=1.96$, $B=0.05$, $P=0.5$, and $N=271{,}233$. This formula has widely been applied in some previous studies of household behaviour (Danlami et al. 2017a, b; Danlami et al. 2018, 2019b). However, in line with Danlami (2017c) and Salkind (1997), the sample was increased by 50% making it to the total of 576 respondents to avoid the problem of non-response bias, size distortion and sample error.

This research embarked upon direct elicitation method (DEM) for data collection using questionnaire instrument. This technique is regarded as the best technique to collect the needed primary information from the selected samples across the study area. Questionnaires were designed based on the strand of literature; and have covered all the necessary information needed for the survey. The data were collected during December 2015 through February 2016. However, it should be known that a pilot study was conducted for instruments' validation

before conducting the main data collection. The exercise of the data collection was conducted with the help of credit officers and extension workers in the study areas as approved by the KNARDA.

Model specification

Tobit regression model was employed to analyse the determinants of credit supply by microfinance banks in the study area. Due to the risk associated with agricultural lending (Barry and Robison 2001), it is discovered that not all of the microfinance banks have observable loans, hence the possibility of censoring known as corner solution. Therefore, to solve this problem in line with econometric modeling, Tobit model was employed in this study (Amemiya 1984; Gujarati and Porter 2009; Wooldridge 2002). In line with some previous studies (Danlami 2017a, b; Greene 1977) the Tobit model could be expressed as

$$y_i = \boldsymbol{x_i\beta} + \varepsilon_i \text{ if } \boldsymbol{x_i\beta} + \varepsilon_i > 0, \tag{5}$$

$$y_i = 0 \text{ if } \boldsymbol{x_i\beta} + \varepsilon_i \leq 0, \tag{6}$$

$$i = 1,2,3, \ldots \ldots \ldots N$$

where y_i is the dependent variable which is defined as the amount of credit disbursed by the microfinance banks to the farmers. X_i is the vector of independent variables, N is the total observations, β is the vector of the coefficients in the model, and ε_i is the error term which is assumed to be normally distributed with zero mean and constant variance σ^2 $\left[\varepsilon \sim N\left(0, \sigma_\varepsilon^2\right)\right]$. The log likelihood function for the Tobit model can be expressed as

$$\mathrm{LL}_{\mathrm{Tobit}} = \sum_0 ln\left[I - \gamma\left(\frac{\beta_i x_i}{\sigma_i}\right)\right] + \sum_+ ln\left[\frac{I}{\sigma_i}\alpha\left(\frac{y_i - \beta_i x_i}{\sigma_i}\right)\right], \tag{7}$$

The "0" indicates the total sum of the zero observations in the sample $\left(y_i = 0\right)$, $''+''$ represents the total observations over the positive observations $(y_i > 0),'' y''$ stands for the standard normal random variable cumulative distribution function (CDF); $''\propto''$ represents the standard probability normal density function (PDF). It is worth noting that maximisation of likelihood function with respect to σ and β will give the maximum likelihood estimates of the parameters, and then the empirical model is presented in the following equation:

$$\mathrm{CRS} = \varphi_{Oi} + \varphi_1 \mathrm{LIQ}_i + \varphi_2 \mathrm{MKS}_i + \varphi_3 \mathrm{PRF}_i + \varphi_4 \mathrm{DIS}_i + \varphi_5 \mathrm{EXP}_i + \varphi_6 \mathrm{ACC}_i + \varphi_7 \mathrm{TRD}_i + \varepsilon_i, \tag{8}$$

where CRS_i represents the total amount of agricultural credit supplied by the microfinance banks. For those who do not supply credit, CRS_i cannot be quantified and is therefore, set to zero (Guiso et al. 1996; Mpuga 2004).

$$\mathrm{CRS}_i = \begin{cases} Y_i^* & if\ Y_i^* > 0 \\ 0 & if\ Y_i^* \leq 0 \end{cases}. \tag{9}$$

LIQ_i is the liquidity of the bank; $\mathrm{MKS}_i$is the number of marketing staff in the microfinance bank; $\mathrm{PRF}_i$is bank's profit; $\mathrm{DIS}_i$is the distance between farmers and microfinance banks in kilometres; $\mathrm{ACC}_i$is dummy for a farmer with a bank account; TRD_irepresents the entrepreneurial ability of a farmer; $\mathrm{EXP}_i$is the years of business experience by the microfinance bank; and ε_i is normal random error term.

The coefficients $\varphi_1, \varphi_2, \ldots, \varphi_7$ provide suitable adjustments to obtain consistent estimates of the effects of changes in the independent variables on y_i for those who supplied loans. The empirical justification of Tobit model using cross section is grounded in the literature (Danlami et al. 2016; Gbadebo et al. 2013; Mailena et al. 2014; Rosli et al. 2013).

Results and discussion

This section provides the discussion of results and findings. It provides the discussion on the variable correlation matrix as well as the descriptive statistics of the variables.

The explanations of variable abbreviations can be found in "Methodology" (Table 1).

Correlation analysis

As a culture of econometric modelling, variables are examined with a view to check the correlation between them. In addition, it gives out preliminary understanding of the potential problem of the presence of multicollinearity among the variables. The correlation coefficients among variables of the model of this study are presented in Table 2. Based on the values of the correlation coefficients, there exists a moderate correlation among the variables included in the estimated model.

The descriptions of variable abbreviations can be found in "Methodology".

Table 1 Descriptive statistics of variables

Variables	Mean	SD	Skewness	Kurtosis
CRS	33.56	20.96	0.97	3.33
EXP	3.02	0.73	1.32	3.34
MKS	3.11	0.49	0.15	3.00
DIS	71.77	39.40	− 0.36	1.58
LIQ	28.64	16.26	1.21	3.14
TRD	0.89	0.32	− 1.46	3.12
PRF	0.55	0.50	− 0.18	1.03
ACC	0.83	0.39	− 1.19	3.24

Table 2 Pairwise correlations coefficients of credit supply model

	LIQ	MRK	PRF	DIS	EXP	ACC	TRD
LIQ	1.000						
MRK	− 0.048	1.000					
PRF	− 0.349	0.102	1.000				
DIS	− 0.073	0.085	0.277	1.000			
EXP	0.252	− 0.045	− 0.012	0.153	1.000		
ACC	− 0.138	0.053	− 0.064	− 0.006	− 0.150	1.000	
TRD	− 0.005	0.042	− 0.031	− 0.116	0.112	0.386	1.000

Results of credit supply model

As previously mentioned, Tobit model was used to analyse the determinants of microcredit supplied to farmers in the study area. Thus, the estimated results as reported in Table 3 have answered the questions earlier raised and therefore, the objective of this study has been addressed. Moreover, this section contains some diagnostics checks and robustness of the estimated model to further ascertain the validity of the credit supply model estimated.

Table 3 Tobit and OLS regression coefficients

Variables	Coefficients/ Tobit Model	S. errors	*t* value	*p* value	Restricted	OLS
LIQ	0.142	0.158	0.900	0.375	0.151	0.113
MKS	10.752	5.085	2.110	0.041**	9.995*	9.368*
PRF	13.953	5.224	2.670	0.011***	9.829	14.30*
DIS	− 0.193	0.069	− 2.800	0.008***		− 0.19**
EXP	1.990	3.486	0.570	0.572	− 0.075	1.870
ACC	10.130	5.693	1.780	0.084*	8.171	9.554
TRD	11.207	5.553	2.020	0.051*	15.37**	9.576*
Constant	2.493	10.784	0.230	0.819	− 8.789	7.313

Dependent variable is *CRS* which is the observable and unobservable amount of credit supplied by the microfinance banks, *LIQ* is the liquidity of the banks measured by current asset over current liability, *MKS* is the number of marketing staff in the microfinance bank, *PRF* is bank's profit dummy with 1 if the bank is making profit and 0 otherwise, *DIS* is the distance between farmers and microfinance bank in kilometres, *EXP* is the years of business experience by the microfinance bank, *ACC* is dummy assigning 1 if the bank considered farmers' with bank account before advancing credit and *TRD* represent the entrepreneurial ability of the microfinance bank's customers assigning 1 for farmers with other activities apart from agriculture. Second to the last model is the restricted tobit while OLS estimates are presented at the last column.

***, **, and * donate statistical significance at 1%, 5%, and 10% respectively.

Estimation and Discussion for credit supply model

Table 3 exhibits the results of the estimated Tobit Model and the OLS Model (OLS Model here reported for the purpose of comparison only because the coefficients of the OLS Model are bias estimate as earlier explain due to data censoring in the DV).

Available evidence from the Tobit model in Table 3 shows that most of the variables are consistent with their hypothesized relationships with the dependent variable, and their influence on the probability of credit supply has been confirmed by their individual levels of significance. The coefficient of *MKS* was found to be statistically significance. This implies that all other things being equal, an increase of one marketing staff employed by microfinance bank increases the predicted rate of credit supply by a factor of 10.8 units. This result in line with those of Bell et al. (1997) and Lapenu and Zeller (2002). The reason may be that having more staffs are likely to increase deposits and extend credit to rural dwellers. Marketing staff in a bank are regarded as a proxy for bank branches, due to their ability to extend financial services closer to people. In fact, this would allow for more effective supervision and monitoring. The introduction of this variable in this model was found to be informative in the analysis of the quantity of credit supplied.

Also, result in Table 3 shows that the coefficient of PRF is statistically significance at 1 percent level. The result indicates that an increase in profit by the microfinance bank is accompanied with the expected increase in credit supply by 13.95 units. Interestingly, this conforms the findings of Bigsten et al. (2003) that lenders allocates credit based on the profits expectation.

Furthermore, turning to the deposit account, the coefficient of this variable was found to be significance at 10 percent level of significance. Result in Table 3 indicates that the predicted chances of being supplied with credit by the banks increases by 11.2% for bank account holders than otherwise. Having a bank account increases the expected credit supply to the account owner relative to non-account holder. This is accordance with the banks screening mechanism where banks are more agile to those with credit reputation which may increase the probability of repayment, and promise more returns. In many cases, borrowers are required to open an account before credit advancement. This mechanism has been used by the microfinance banks to increase the chances of repayment. Similarly, having more deposits account by a bank will increase the total deposits of this bank. This finding coincides with the findings of Donkor and Duah (2013) and Papias and Ganesan (2010).

At 10% level of significance, estimates from Table 3 justified the importance of TRD in the analysis of credit supply. In comparison with full-time farmers, the probability of being supplied with credit increases with off-farm commitment. Conditional with other regressors, the expected credit supply is 10.1 higher for the farmers that engaged in extra income activities than otherwise. Logically, the result shows that lenders might prefer to supply credit to borrowers with other commitment in non-agricultural sector to ensure repayment. This is because farmers with additional income from non-farming have more repayment capacity in the event of crop failure. Also, this corroborates with the argument that banks might prefer to offer credit to the farmers who engaged in other off-farming businesses than otherwise though previous studies that utilized this variable in credit-supply equation to compare or

contrast are rarely available. However, this result may be comparable to other studies using demand-side data (Kuri and Laha 2011; Mpuga 2004).

Furthermore, the estimated result in Table 3 shows a systematic negative connection between credit supply and distance (DIS) at 1 percent level of significance. An increase in one kilometre away from the microfinance banks reduces the expected supply of credit to farmers by a factor of 0.2. The probability of supplying credit decreases as farmers living far away from the microfinance banks, compared to those living closer to lending agencies. More specifically, this suggests that transaction cost is likely to increase if a borrower is living far away from a lender. Although previous studies have used demand-side approach to arrive at their conclusions, however, the result corresponds to the finding that an increase in distance from financial institutions increases the likelihood that a household may not be supplied with credit (Akudugu 2013; Chi and City 2014; Kiplimo 2015; Rosana and Muturi 2014). This finding is important, because distance to the lending agencies will raise the communication and travelling costs for rural farmers, and subsequently lenders may find it very difficult to supervise, monitor or to manage transactions. Perhaps, farmers who are distant away from the credit suppliers may rely more on neighbourhood borrowing such as friends and relatives, due to the price and non-price cost associated with long distance borrowing.

It appears from the estimated results in Table 3 that the coefficients of LIQ and EXP turned out positive though not significant, but together does not deviate from the theoretical and logical expectations. However, the fact that LIQ and EXP turned out with less statistical power suggests that these two variables may not be good for policy formulation, and this is something that call for further investigation.

Diagnostic checks for credit supply model

Some statistical tests have been conducted to strengthen the internal validity and to check for violation of certain assumptions. Estimates from Table 3 have been subjected to the specification test using Cameron and Trivedi's decomposition information matrix (IM) (Cameron and Trivedi 1990). However, it appears statistically insignificant suggesting homoscedastic normal residual and, therefore, fit for analysis. Similarly, different types of normality tests have been conducted which include Shapiro–Wilk test (Shapiro and Wilk 1965) and Shapiro–Francia (Shapiro and Francia 1973) as suggested (Gould 1992; Gould and Rogers 1991). But, evidence from

Table 4 Goodness of fit tests

Tests	*p* value
IM test	0.907
Skewness and Kurtosis test	0.984
Shapiro–Wilk *W* test	0.734
Shapiro–Francia *W*' test	0.734
Ramsey test	0.134

these tests as contained in Table 4 has failed to reject the hypothesis that the data is normally distributed. Same result was obtained using Skewness and kurtosis normality tests. In addition, the result of Ramsey (1969) test is presented in the last raw of Table 4. Evidence from the Ramsey's test has found no evidence for omitted variables.

Notwithstanding, Table 4 presents some statistical tests for internal validity, specification and model selection. The Wald χ^2 and LR χ^2tests statistics are significant at 1%, rejecting the hypothesis that all parameters are simultaneously not different from zero. This indicates that the estimated Tobit model as a whole is statistically significant and well fitted for the analysis.

Conclusions

As farm credit enhance farm performance and productivity, thereby ensuring a significant improvement in rural welfare and farmers' income, this study investigates the intensity of agricultural credit supply by micro-finance banks in Nigeria. The result of the estimated Tobit model indicates that an additional employment of marketing staff by bank increases the intensity of agricultural loan supplied by microfinance banks to farmers. In conformity with the literature, the coefficient of profit is statistically significance suggesting that an increase in profit is associated with an additional supply of credit by microfinance bank to the farmers. This finding may not be surprising since credit supply is more related with profit-maximisation motive. Moreover, having deposit account is one of the important factor of credit access. With positive significance, it appears from the Tobit regression model that having deposit account will increase the expected amount of credit supply by banks to farmers. This finding justified the banks' screening mechanism; where banks are more willing to lend credit to those with reputation and whom they know; for the fact that banks may lessen the probability of defaulting by the farmers. Turning to the effects of distance to lending agencies, some interesting finding emerged. Result indicates that cost of borrowing is likely to skyrocket if a farmer is leaving far away from a lender. Thus, makes a lender to ration credit supply to the farmers.

In a nutshell, greater elements of consistencies have been observed throughout the estimations, re-affirming the validity and robustness of estimates from the agricultural credit supply model. For instance, the significance of farm profit in the estimated model signifies that while farm profit is related with borrowing from different source, profit making farmers are more likely to become satisfied-borrowers and hence supplied with more finance. On the other hand, although variables such as banks' liquidity and years of experience in operation have expected sign (i.e. positive relationship with the dependent variable), they were found to be statistically insignificant as per determining the intensity of loan provision by the micro-finance bank in the area of study.

Policy implications

Various policy recommendations can be arrived at on the basis of the findings of this study. From the policy implication assessment with respect to subsistence farming and tenure-ship, pro-poor credit policies are required for the establishment of new agencies and financial institutions devoted to agricultural sector. Similarly, an integrated system of forward-looking policies based on tax and subsidy-regimes to augment desired incentives for private financial sector and NGOs to lend money to the farmers are needed. These may not only raise the productive capacity of the rural households through better and efficient utilisation of farm resources, but it will discourage labour-mobility, hence an increase in rural productivity that may lead to increase in rural welfare. Furthermore, there is a need for the provision of subsidized credit agencies that are formal in nature which are to be devoted to the rural farmers to cushion the financial gaps and inequalities.

Additionally, the importance of non-farm commitment is obvious. Hence, there is a need for investing and uplifting of human capital in the country, thereby creating additional benefits to the financial arena. Policies particularly, should emphasis on development of rural areas, viz., the activities that provide and promote off-seasonal occupations. Moreover, the strengthening of local markets and provision of good and adequate rural infrastructure such as road networks would assist in the process of pro-famers transformation in the financial system modification.

Based on the study findings, the complete concern of the policy formulation should target the regions where there is low access to credit, or there is prevalent credit limitation due to immense demand—such as the one observed in both Dambatta and Rano Zones. The policy designed based on the alert from specific region could eliminate regional inequalities and differences, particularly in the financial reforms and as well in the development process in general. Overall, these policies would pave way for more credit supply by the various financial agencies.

Limitations and suggestions for future researches

Despite the effort made in its analysis, this study has acknowledged the existence of some limitations that need further investigations. In the first place, this study is static in nature, i.e. the study did not conduct a dynamic analysis of agricultural credit supply. Hence, future studies can employ the use of time-series longitudinal data spanning over several years to verify the findings and conclusion of this study. Also, there is a need for future studies on the credit supply that investigate formal and informal credit market contracts with special reference to lenders' attributes, revenue versus cost and repayment rate in relation to credit supply.

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Data availability Data for this paper are available on request.

Code availability Software application.

Compliance with ethical standards

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